TECHNOLOGICAL QUALITY AND UTILIZATION OF POTATO TUBERS

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ABSTRACT: Increasing concerns have been verified with regard to the quality factor of potato tubers and their correct form of use and consumption. The purpose of this research was to determine the technological quality of potato tuber cultivars and identify the best forms of use and consumption. A completely randomized experimental design was adopted with 18 treatments represented by cultivars Agata, Apuã (IAC-5977), Aracy (IAC-2), IAC Aracy Ruiva, Asterix, Bintje, Dali, Clone IAC-6090, Itararé (IAC-5986), Laguna, Remarka, Liseta, Mondial, Novita, Oscar, Picasso, Santana, and Solide, with four replications. Specific gravity showed a positive correlation with starch content, texture, pulp pH, and soluble solids, and was negatively correlated with reducing sugars. The technological characteristics represented by specific gravity, dry matter content, texture, starch content, reducing sugars, pulp pH, titrable acidity, and soluble solids are influenced by genotype or cultivar. Cultivars Oscar, Itararé, IAC Aracy Ruiva, Clone IAC-6090, Aracy, Solide, Asterix, Santana, and Laguna were outstanding with best characteristics for frying, mashing and roasting. Mondial, Picasso, Novita, Dali, and Agata are appropriate for boiling, and more specifically for salads. In turn, potato cultivars Apuã, Remarka, Bintje, and Liseta are suitable for mashing and for roasting.
Key words: *Solanum tuberosum*, dry matter, reducing sugars, starch content

QUALIDADE TECNOLÓGICA E UTILIZAÇÃO DE TUBÉRCULOS DE BATATA

RESUMO: Atualmente tem ocorrido crescente preocupação com o fator qualidade da batata e a forma correta de utilização para o consumo. O objetivo deste trabalho foi determinar a qualidade tecnológica dos tubérculos de cultivares de batata, visando identificar a melhor forma de utilização e consumo. O delineamento experimental foi inteiramente casualizado com 18 tratamentos, representados pelos cultivares Agata, Apuã (IAC-5977), Aracy (IAC-2), IAC Aracy Ruiva, Asterix, Bintje, Dali, Clone IAC-6090, Itararé (IAC-5986), Laguna, Remarka, Liseta, Mondial, Novita, Oscar, Picasso, Santana e Solide, com quatro repetições. O peso específico apresentou correlação positiva com o teor de amido, textura, pH de polpa e sólidos solúveis e negativa com os teores de açúcares redutores. As características tecnológicas representadas pelo peso específico, teor de matéria seca, textura, teor de amido, açúcares redutores, pH da polpa, acidez titulável e teor de sólidos solúveis são influenciadas pelo genótipo ou cultivar. Destacaram-se, com melhores características para fritura, purê e assada os cultivares Oscar, Itararé, IAC Aracy Ruiva, Clone IAC-6090, Aracy, Solide, Asterix, Santana e Laguna. São apropriados para o cozimento e especificamente para salada os cultivares Mondial, Picasso, Novita, Dali e Agata. Já os cultivares Apuã, Remarka, Bintje e Liseta são adequados para purê e assadas.
Palavras-chave: *Solanum tuberosum*, matéria seca, açúcares redutores, teor de amido

INTRODUCTION

At present, the characteristics required by the potato-consuming market in Brazil are experiencing transformations with respect to fresh and industrial quality. Potato chips are predominant and are the consumer's preferred type in potato industrialization. In the fresh market, consumers select potatoes by visual characteristics such as shape, color, and skin brightness. However, there has been an increasingly higher search for information on the part of consumers with regard to appropriate uses of the product, that is, for frying, baking, salads, or mashing. Between 90 and 98% of the domestic potato yield have been sold fresh, and almost all of it is used by consumers in the form of potato fries (Lopes & Buso, 1997); an expressive amount is also consumed in baked form.

During the frying and baking processes, the dry matter and reducing sugars contents are the most important interferers, since tuber characteristics are variable, due to environmental and cultivar-intrinsic factors. Thus, specific gravity can indirectly provide a dry matter content estimate, and is also reated to industrial yield, oil absorption during frying, and final product quality. Specific gravity studies have revealed that a positive correlation

exists with dry matter content (Schippers, 1976), and a negative correlation exists with reducing sugars content (Iritani & Weller, 1974; Salamoni et al., 2000).

Also, a nonenzymatic browning develops during the frying process, which has been attributed to a reaction between reducing sugars (glucose and fructose), the amino acid lysine, and proteins (known as Maillard reaction); as the frying process is extended, the product may become burned (caramelization), resulting in a bitter off-flavor. A low content of reducing sugars limits the excessive browning of the final product (Gould, 1988). Kadam et al. (1991a) verified a variation from 0.5 to 2.0% in reducing sugars contents in potato tubers. In turn, tubers with contents higher than 2% are unacceptable for frying (Pereira, 1987).

Other factors that may interfere in a negative and/or indirect way on the technological quality of tubers are pulp pH, total acidity, and starch content. The pH index determines deterioration potential by fermentation and the activity of enzymes (Cecchi, 1999). The phosphorylase enzyme acts predominantly on starch breakdown (Jadhav et al., 1991), with maximum activity at pH 5.5 (Iritani & Weller, 1973). Invertase, on the other hand, promotes sucrose breakdown into glucose and fructose (Sowokinos, 1990), and presents an optimum point at pH 4.7 (Pressey, 1966). In addition, pulp pH is variable and presents a negative correlation (-0.86) with reducing sugars accumulation (Iritani & Weller, 1973). In turn, the total acidity parameter quantifies organic acids present in foods and, in general, there is a tendency of reduction in their contents because of respiration and/or due to conversion into sugars (Chitarra & Chitarra, 1990), which could contribute toward browning of the fried product.

Starch comprises 65-80% of the dry weight of tubers; however, variation in starch is mainly due to genetics (Pereira, 1987; Kadam et al., 1991a). Since starch comprises the largest part of dry matter, it has direct influence on technological quality, especially with regard to the texture of the processed products (Kadam et al., 1991b).

The objective of this work was to determine the technological quality of potato cultivar tubers, in order to identify their best forms of use and consumption.

MATERIAL AND METHODS

Large-sized potato tubers of several cultivars, from plantings carried out during the 2000 "das águas" season in the municipality of São Manuel, SP (22º44' S; 48º34' W), were used in the experiment conducted under laboratory conditions. The experimental design was completely randomized, with four replicates and 18 treatments, represented by potato cultivars Agata, Apuã (IAC-5977), Aracy (IAC-2), IAC Aracy Ruiva, Asterix, Bintje, Dali, Clone IAC-6090, Itararé (IAC-5986), Laguna, Remarka, Liseta, Mondial, Novita, Oscar, Picasso, Santana, and Solide.

Tuber technological characteristics such as specific gravity, dry matter content, texture, starch content, reducing sugars, pulp pH, titrable acidity, and soluble solids content were evaluated. In order to accomplish these determinations, recently-harvested tuber samples were collected and then washed, shade-dried, and taken to the laboratory for analytical procedures.

The tubers were weighed in open air and in water, on a hydrostatic precision balance, for specific gravity determination. Tuber dry matter content was calculated indirectly using the specific gravity results, following a methodology by Schippers (1976). Four readings were taken from each tuber for texture determination, by means of a texturometer with a 20-mm penetration distance and a 2.0 mm s^{-1} speed, using a TA 9/1000 probe tip. The starch content was quantified in tubers dried in a forced air circulation oven at a temperature near 70ºC until constant weight was achieved, and later ground in a Wiley type, stainless steel mill; determinations were made according to the methodology proposed by AOAC (1992).

Reducing sugars content was quantified in 50 g pulp samples according to methodology by Nelson (1944) and Somogy (1945); readings were made in a digital spectrophotometer at 535 nm. The pH readings were determined in 50 g samples of pulp ground with 100 mL distilled water, in a digital pH-meter. For titrable acidity determination, 50 g of pulp ground with 100 mL distilled water were used; the mixture was filtered and titrated with a 0.10 mol L^{-1} sodium hydroxide solution, using phenolphthalein as end point indicator, in a digital pH-meter with a potentiometer capable of measuring pH values of up to 8.1. For soluble solids quantification, the juice extracted from a slice of the tubers was used. Two droplets of juice were used; the droplets were placed on the prism of an electronic refractometer; the ºBrix reading was taken after one minute.

Data were submitted to analysis of variance using the F test and means were compared by Tukey test at 5%. Several tuber characteristics were correlated, in order to determine the degree of association between them and the data were compared at $P < 0.01$; $P < 0.05$, and $P < 0.10$.

RESULT AND DISCUSSION

For all characteristics evaluated there were differences between studied cultivars (Tables 1 and 2). Specific gravity showed values ranging between 1.0831 kg L^{-1} and 1.0527 kg L^{-1}. 'Clone IAC-6090' obtained the highest value, while 'Mondial' obtained the lowest. Therefore, taking only specific gravity, and consequently yield and oil absorption into consideration during the frying processes (Lulai & Orr, 1979), the cultivars with best

results for frying belong to the interval from 1.0701 to 1.0850 kg L^{-1}, that is, Solide, Aracy, Itararé, IAC Aracy Ruiva, Oscar, and Clone IAC-6090, while 'Mondial' showed the poorest performance for this cooking procedure.

With respect to dry matter content, a classification identical to that of specific gravity was observed. 'Clone IAC-6090' and the Mondial cultivar presented extreme values, at 22.4 and 15.7%, respectively. The values for dry matter are below the minimum intervals required for obtaining fried products with excellent characteristics, as described by Gravoueille (1997). The exceptions were cultivar Oscar and the Clone IAC-6090, which showed dry matter values of 21.5 and 22.4%, respectively. Cacace et al. (1994) suggested that dry matter content values should be assembled into three groups: high dry matter content (contents higher than 20.0%), intermediate dry matter content (contents between 18.0 and 19.9%), and low dry matter content (contents lower than 17.9%). Therefore, according to this classification, cultivars Aracy, Itararé, IAC Aracy Ruiva, Oscar, and Clone IAC-6090 belong to the high dry matter content group. Conversely, 'Remarka', 'Apuã', 'Laguna', 'Santana', 'Asterix', and 'Solide' were categorized in the group showing an intermediate dry matter content. The low dry matter content group, in turn, comprised 'Mondial', 'Novita', 'Dali', 'Agata', 'Picasso', 'Liseta', and 'Bintje'. According to Brune et al. (1994), cultivar Bintje showed a dry matter content of 19%, and was therefore classified as having medium dry matter content, in disagreement with this work's results. This is due to the genotype × environment interaction effect, since variations in dry matter contents of tubers from the same cultivar produced in different environments are common (Beukema & Zaag, 1990; Cacace et al., 1994; Melo, 1999).

The specific gravity variable showed a positive correlation with starch content (r = 0.51; $P < 0.05$), and a negative correlation with reducing sugars contents (r = -0.58; $P < 0.05$) (Table 3), confirming results by Salamoni et al. (2000) and Gould (1988). It is also interesting to point out that specific gravity showed a positive correlation with texture (r = 0.82; $P < 0.01$), pH (r = 0.55; $P < 0.05$), and soluble solids (r = 0.44; $P < 0.10$).

Table 1 - Specific gravity, dry matter content, pulp texture, and starch content of potato cultivar tubers.

Cultivar	Specific gravity	Dry matter	Texture	Starch
	kg L^{-1}	%	N	%
AGATA	1.0560 ghi	16.4 ghi	6.74 fg	66.0 abcd
APUÃ (IAC-5977)	1.0650 defg	18.4 defg	8.15 abcde	68.2 abc
ARACY (IAC-2)	1.0737 abcd	20.3 abcd	8.04 abcde	71.4 a
IAC ARACY RUIVA	1.0748 abc	20.6 abc	8.36 abc	69.6 ab
ASTERIX	1.0685 cde	19.1 cde	8.15 abcde	66.2 abcd
BINTJE	1.0628 efgh	17.9 efgh	7.39 bcdef	64.1 bcde
DALI	1.0546 hi	16.1 hi	7.32 cdef	61.0 de
CLONE IAC-6090	1.0831 a	22.4 a	8.50 ab	68.4 abc
ITARARÉ (IAC-5986)	1.0747 abc	20.5 abc	8.16 abcde	69.6 ab
LAGUNA	1.0661 cdef	18.6 cdef	7.64 abcdef	64.7 abcd
REMARKA	1.0632 efgh	18.0 efgh	8.55 ab	66.5 abcd
LISETA	1.0611 efghi	17.5 efghi	7.13 def	68.6 abc
MONDIAL	1.0527 I	15.7 i	7.01 efg	65.2 abcd
NOVITA	1.0543 hi	16.0 hi	5.97 g	65.9 abcd
OSCAR	1.0793 ab	21.5 ab	8.69 a	65.1 abcd
PICASSO	1.0584 fghi	16.9 fghi	6.83 fg	57.6 e
SANTANA	1.0666 cdef	18.7 cdef	8.19 abcd	62.5 ed
SOLIDE	1.0706 bcde	19.6 bcde	8.28 abcd	66.5 abcd
Overall mean	1.0659	18.6	7.73	65.9
F test for:				
Cultivars	23.096*	23.095*	11.668*	5.986*
CV%	0.35	4.43	5.74	4.13
lsd (Tukey at 5%)	0.0097	2.13	1.15	7.07

Means followed by the same letter in the column do not differ by Tukey test at 5%.
*Significant at 5%.

Table 2 - Reducing sugars contents and total titrable acidity, soluble solids, and pulp pH of potato cultivar tubers.

Cultivar	Reducing sugars	Titrable acidity	Soluble solids	Pulp pH
	---------- % ----------		° Brix	
AGATA	0.82 abc	0.150 ab	5.46 bcd	5.56 ab
APUÃ (IAC-5977)	0.43 cde	0.155 ab	5.77 abcd	5.62 ab
ARACY (IAC-2)	0.55 abcde	0.170 ab	5.95 abcd	5.57 ab
IAC ARACY RUIVA	0.40 cde	0.178 a	6.23 abc	5.72 ab
ASTERIX	0.82 abc	0.145 ab	5.94 abcd	5.53 ab
BINTJE	0.51 bcde	0.160 ab	5.19 cd	5.57 ab
DALI	0.58 abcde	0.173 ab	5.70 abcd	5.57 ab
CLONE IAC-6090	0.61 abcde	0.158 ab	6.69 a	5.69 ab
ITARARÉ (IAC-5986)	0.32 de	0.165 ab	6.42 ab	5.68 ab
LAGUNA	0.49 bcde	0.145 ab	5.12 cd	5.94 a
REMARKA	0.87 ab	0.143 ab	6.72 a	5.61 ab
LISETA	0.58 abcde	0.173 ab	5.07 cde	5.45 ab
MONDIAL	0.96 a	0.165 ab	4.88 de	5.40 ab
NOVITA	0.72 abcd	0.158 ab	5.41 bcd	5.50 ab
OSCAR	0.35 de	0.148 ab	5.92 abcd	5.71 ab
PICASSO	0.61 abcde	0.140 b	5.32 bcd	5.16 b
SANTANA	0.52 bcde	0.140 b	5.55 abcd	5.59 ab
SOLIDE	0.26 e	0.145 ab	3.91 e	5.77 ab
Overall mean	0.58	0.156	5.62	5.59
F test for:				
Cultivars	5.409*	3.243*	9.308*	1.950*
CV%	29.25	8.72	8.03	4.20
lsd (Tukey at 5%)	0.438	0.035	1.174	0.610

Means followed by the same letter in the column do not differ by Tukey test at 5%.
*Significant at 5%.

Table 3 - Simple correlation coefficients (r) between specific gravity, texture, starch and reducing sugars contents, pulp pH, titrable acidity, and soluble solids of potato cultivar tubers.

Characteristics	Texture	Starch	Reducing sugars	Pulp pH	Titrable acidity	Soluble solids
Specific gravity	0.82***	0.51**	-0.58**	0.55**	0.00	0.44*
Texture		0.38	-0.44*	0.56**	-0.13	0.44*
Starch			-0.17	0.44*	0.48**	0.32
Reducing sugars				-0.50**	-0.10	0.12
Pulp pH					-0.01	0.10
Titrable acidity						0.15

*Significant at $P < 0.10$, **Significant at $P < 0.05$, ***Significant at $P < 0.01$.

The mean texture value for fresh tubers was 7.73 N, ranging between 5.97 and 8.69 N. Even though this variable presented a positive and significant correlation with specific gravity (Table 3), the results shown in Table 1 indicated that no direct relation exists, since cultivar Oscar showed the highest texture value (8.69 N), while 'Novita' showed the lowest (5.97 N), not corresponding to the cultivars with the highest and lowest specific gravities. Therefore, other unknown factors are present in texture quantification.

Starch contents oscillated between 57.6 and 71.4%, in part confirming results obtained by Pereira (1987), since cultivars Picasso, Dali, Santana, Bintje, and Laguna showed starch values lower than those presented by that author. Cultivar Aracy, however, showed the highest starch content, while 'Picasso' showed the lowest content.

Oscillations in pH (5.4 to 6.2), titrable acidity (26.5 to 60.9 mL 100 g^{-1} NaOH), soluble solids (5.1 to 6.8 °Brix), and reducing sugars values (0.7 to 1.3%) were observed in six potato cultivars. Of these, cultivar Bintje showed values of 5.8 ± 0.4, 36.3 ± 6.9, 6.3 ± 0.5, and 1.1 ± 0.2, while 'Aracy' showed values of 5.7 ± 0.2, 44.3 ± 16.6, 6.1 ± 0.2, and 1.0 ± 0.3 for pH, titrable acidity, soluble solids, and reducing sugars, respectively (Paschoalino et al., 1983). Thus, cultivars Bintje and Aracy showed pH values similar to those obtained by the authors of this work. However, 'Bintje' showed lower soluble solids and reducing sugars values, while 'Aracy' obtained a similar soluble solids content and a lower reducing sugars content.

Cultivar Solide showed the smallest °Brix value (3.91), while 'Remarka' and 'Clone IAC-6090' showed the highest values, with 6.72 and 6.69 °Brix, respectively. Therefore, these two cultivars contain the highest sucrose values; however, according to Pereira (1987), these results do not interfere with tuber quality. The texture variable showed a positive and significant correlation ($P < 0.10$) with soluble solids contents, in the order of 0.44 (Table 3). Cultivars Liseta, Mondial, and Solide showed lower values than those described by Paschoalino et al. (1983), while the other cultivars showed values within the described interval.

The correlation study between pH and reducing sugars contents (Table 3) showed a negative value (r = -0.50) and significance at $P < 0.05$, confirming results obtained by Iritani & Weller (1973). The correlation showed a positive (r = 0.55) and significant value at $P < 0.05$ between variables specific gravity and pH. These results allow us to suppose that a high pH value favors specific gravity and a smaller reducing sugars content.

Cultivar Picasso showed the lowest pulp pH value (5.16), while 'Laguna' showed the highest value, at 5.94. The pH value for cultivar Picasso was lower than the interval reported by Paschoalino et al. (1983); the other cultivars showed pH values compatible with that interval. Tubers of cultivar Laguna have a greater probability of undergoing a faster fermentation than 'Picasso' tubers, since the sucrose breakdown process and the formation of reducing sugars are more favored in 'Picasso', in addition to the fact that cultivar Laguna tubers showed greater propensity to undergo breakdown of starch molecules.

The contents of reducing and/or non-reducing sugars are closely related to the quality of the final product; therefore, sugar content increases may negatively reflect on this trait. There was little variation in titrable acidity percentage, ranging between 0.140 and 0.178%. Cultivars Picasso and Santana showed the smallest value (0.140%), differing from 'IAC Aracy Ruiva' (0.178%). Hence, cultivars Picasso and Santana showed a more suitable behavior for this variable.

Cultivars 'Oscar', 'Itararé', and 'IAC Aracy Ruiva' showed suitable characteristics to be used as fried potatoes. The other cultivars showed dry matter contents lower than 20% and/or reducing sugars contents above 0.4%. However, based on the total solids contents found by Paschoalino et al. (1975) and Carvalho et al. (1977), 'Clone IAC-6090' and cultivars Aracy, Solide, Asterix, Santana, and Laguna can also be used for fries.

Baked tubers can be classified as either mealy or waxy (Kadam et al., 1991b). The mealy constitution is due to a high dry matter content; the tissues have a dry appearance and become immediately crumbled upon baking, and physical disintegration of the tuber structure occurs. Mealy-textured tubers are preferred for roasted, mashed, and fried potatoes. Waxy-textured tubers display a moist appearance and less disintegration after cooking, and the tuber's structure is left intact. These are suitable for making salads and creams. Therefore, cultivars Mondial, Picasso, Novita, Dali, and Agata are more appropriate for the preparation of salads, while 'Apuã', 'Remarka', 'Bintje', and 'Liseta' should be preferred for mashed and roasted potatoes. However, tubers used in boiling processes do not present guaranteed quality and consistency, because these characteristics are associated with intrinsic characteristics of the tuber, such as cell size, cell wall makeup, starch content, size, location, and characteristics of starch grains, and other physical variables such as time to become cooked and water temperature.

CONCLUSIONS

Technological characteristics represented by specific gravity, dry matter content, texture, starch content, reducing sugars, pulp pH, titrable acidity, and soluble solids content are influenced by genotype or cultivar.

Cultivars Oscar, Itararé, IAC Aracy Ruiva, Clone IAC-6090, Aracy, Solide, Asterix, Santana, and Laguna are suitable for frying, mashing, and roasting.

Cultivars 'Mondial', 'Picasso', 'Novita', 'Dali', and 'Agata' are suitable for boiling, and specifically appropriate to be consumed in the form of salads.

Tubers of cultivars Apuã, Remarka, Bintje, and Liseta are suitable for mashed and for roasted potatoes.

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REFERENCES

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS. **Official methods of analisys of the AOAC.** 11.ed. Washington, 1992. 1015p.

BEUKEMA, H.P.; ZAAG, D.E. van der **Introduction to potato production.** Wageningen: PUDOC, 1990. 208p.

BRUNE, S.; MELO, P.E. de; LIMA, M.F. Resistência a *Alternaria solani*, características agronômicas e qualidade de fritura em clones de batata imunes a PVY e PVX. **Horticultura Brasileira**, v.12, p.125-130, 1994.

CACACE, J.E.; HUARTE, M.A.; MONTI, M.C. Evaluation of potato cooking quality in Argentina. **American Potato Journal**, v.71, p.145-153, 1994.

CARVALHO, R.; TRAVAGLINI, D.A.; MATSURA, P.T.; CABRAL, A.C.D.; MORI, E.E.M. Comportamento das variedades de batatinha Bintje e Radosa na obtenção de flocos de batatinha e fritas do tipo "chips". **Boletim do Instituto de Tecnologia de Alimentos**, n.54, p.135-152, 1977.

CECCHI, H.M. **Fundamentos teóricos e práticos em análise de alimentos.** Campinas: UNICAMP, 1999. 212p.

CHITARRA, M.I.F.; CHITARRA, A.B**. Pós-colheita de frutos e hortaliças:** fisiologia e manuseio. Lavras: FAEPE, 1990. 320p.

GOULD, W.A. Quality of potatoes for chip manufacture. In: SYMPHOSIUM POTATO QUALITY INDUSTRY NEEDS FOR GROWTH. Fort Collins, 1988. **Proceedings.** Fort Collins: The Potato Association of the America. 1988. p.10-20.

GRAVOUEILLE, J.M. Maîtriser la teneur en sucres des tubercules**. Pomme de Terre Frites,** n.502, p.39-46, 1997.

IRITANI, W.M.; WELLER, L. The development of translucent end tubers. **American Potato Journal**, v.50, p.223-233, 1973.

IRITANI, W.M.; WELLER, L.D. Some factors influencing the pH of apical and basal portions of Russet Burbank and Norgold potatoes. **American Potato Journal**, v.51, p.119-125, 1974.

JADHAV, S.J.; MAZZA, G.; DESAI, U.T. Postharvest handling and storage. In: SALUNKHE, D.K.; KADAM, S.S.; JADHAV, S.J. (Ed.) **Potato production, processing and products.** Boca Raton: CRC Press, 1991. cap.4, p.69-109.

KADAM, S.S.; DHUMAL, S.S.; JAMBHALE, N.D. Structure, nutritional composition, and quality. In: SALUNKHE, D.K.; KADAM, S.S.; JADHAV, S.J. (Ed.) **Potato production, processing and products.** Boca Raton: CRC Press, 1991a. cap.2, p.9-35.

KADAM, S.S.; WANKIER, B.N.; ADSULE, N.R. Processing. In: SALUNKHE, D.K.; KADAM, S.S.; JADHAV, S.J. (Ed.) **Potato production, processing and products.** Boca Raton: CRC Press, 1991b. cap.5, p.111-154.

LOPES, C.A.; BUSO, J.A. Escolha da cultivar. In: LOPES, C.A.; BUSO, J.A. (Ed.) **Cultivo da batata (*Solanum tuberosum* L.).** Brasília: EMBRAPA, CNPH, 1997. p.3-4. (Instruções Técnicas, 8).

LULAI, E.C.; ORR, P.H. Influence of potato specific gravity on yield and oil content of chips. **American Potato Journal**, v.56, p.379-390, 1979.

MELO, P.E. de Cultivares de batata potencialmente úteis para processamento na forma de fritura no Brasil e manejo para obtenção de tubérculos adequados. **Informe Agropecuário**, v.20, p.112-119, 1999.

NELSON, N.A. Photometric adaptation of Somogy method for the determination of glucose. **Journal of Biological Chemistry**, v.153, p.375-380, 1944.

PASCHOALINO, J.E.; FERREIRA, V.L.P.; POMPEU, R.M. Aptidão das variedades de batatinha Bintje e Radosa para processamento de fritas à francesa e congeladas e purê congelado. **Coletânea do Instituto de Tecnologia de Alimentos**, v.6, p.431-444, 1975.

PASCHOALINO, J.E.; FERREIRA, V.L.P.; TOCCHINI, R.P.; BERNHARDT, L.W. Avaliação de cultivares de batatinha (*Solanum tuberosum* L.) para processamento na forma de fritas congeladas. **Coletânea do Instituto de Tecnologia de Alimentos**, v.13, p.33-57, 1983.

PEREIRA, A.S. Composição química, valor nutricional e industrialização. In: REIFSCHNEIDER, F.J.B. (Coord.) **Produção de batata.** Brasília: Linha Gráfica, 1987. p.12-28.

PRESSEY, R. Potato sucrose synthetase: purification, properties, and changes in activity associated with maturation**. Plant Physiology**, v.44, p.759-764, 1966.

SALAMONI, A.I.; PEREIRA, A. da S.; VIÉGAS, J.; CAMPOS, A.D.; CHALÁ, C.S. de A. Variância genética de açúcares redutores e matéria seca e suas correlações com características agronômicas em batata. **Pesquisa Agropecuária Brasileira**, v.35, p.1441-1445, 2000.

SCHIPPERS, P.A. The relationship between specific gravity and percentagem dry matter in potato tubers. **American Potato Journal**, v.53, p.111-122, 1976.

SOMOGY, M. Determination of blood sugar. **Journal of Biological Chemistry,** v.160, p.69-73, 1945.

SOWOKINOS, J. Effect of stress and senescence on carbon partitioning in stored potatoes. **American Potato Journal**, v.67, p.849-857, 1990.

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